Energy Storage Workshop

California Public Utility Commission

Energy Storage OIR

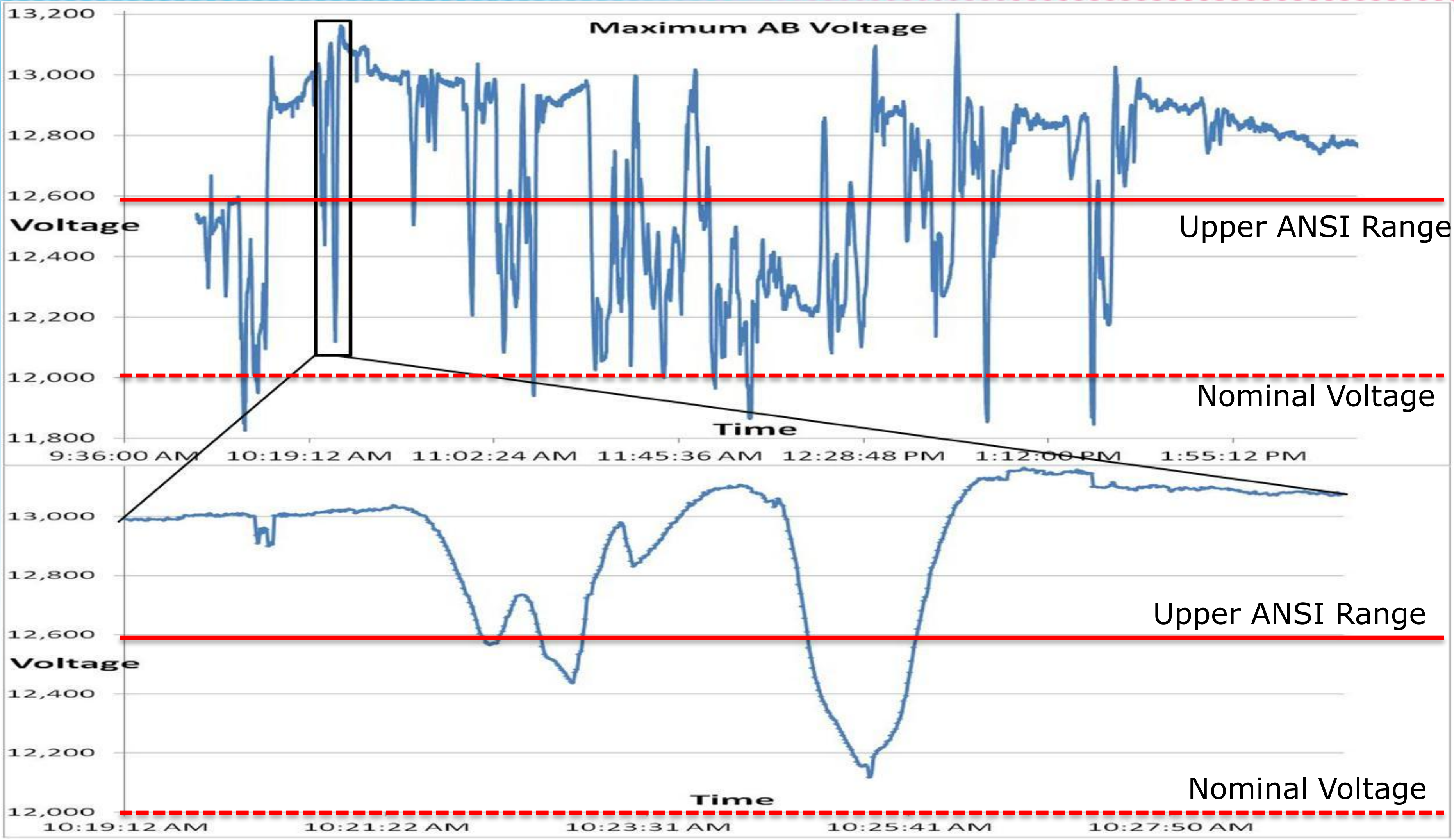
Victor Romero, P.E.
Director, Asset Management and Smart Grid Projects

January 14, 2013

SDG&E's Energy Storage Strategy

- Determine the resource mix over the next 10-15 years
  - Impact to local and territory-wide grid system
- Estimate the actual power and energy output of renewable resources
  - Impacts of intermittency and congestion, at various times, seasons, locations, weather conditions and states-of-readiness
- Investigate mitigation strategies for the intermittency
  - Storage, current generation, fast ramping generation, VAr injection
  - Case for why - without mitigation - reliability will suffer - and how much
  - Cost of the alternatives (conventional peaker plants)
- Develop software/hardware requirements for systems that will manage load balancing in the face of increasing generation variability
- Compute business case for implementing mitigation strategies
  - High level requirements, cost, pros/cons, risks, dependencies
- Understand "true impact" of intermittent renewable resources
  - Installed and levelized cost perspective, \$/kW and \$/kWh

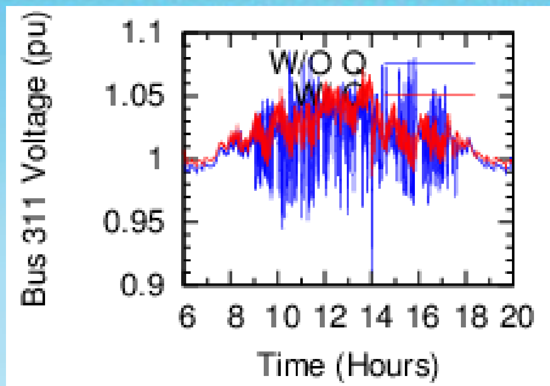
PV Issues - Intermittency



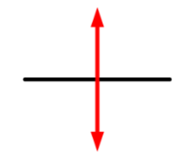
Top half of graph: one day of 1 second voltage readings at 12 kV transformer near a customer's 1 MW PV system
Bottom half of graph: 10 minutes of 1 second data magnified from the one day data above

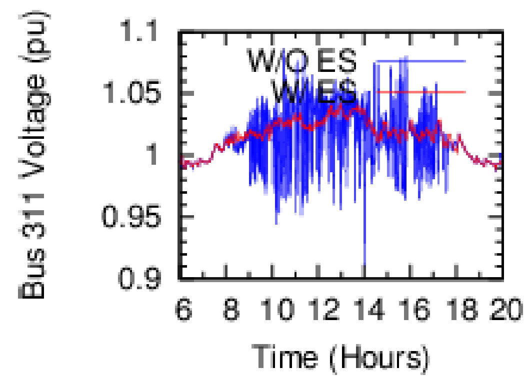
PV Intermittency Mitigation
Based Upon Modeling with Smart Inverters

Blue = Without Mitigation   Red = With Mitigation

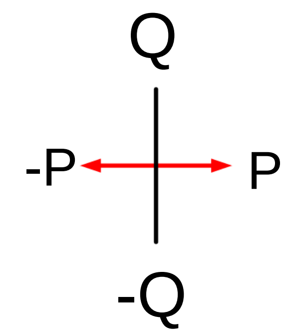


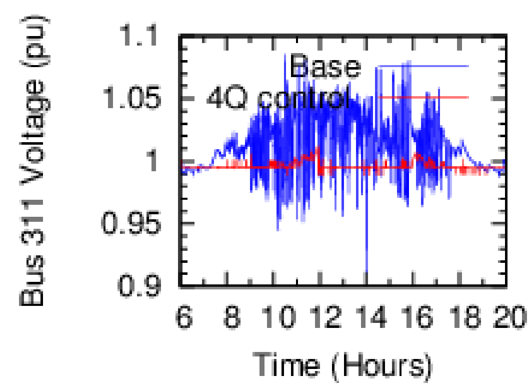
With and without dynamic VAr device



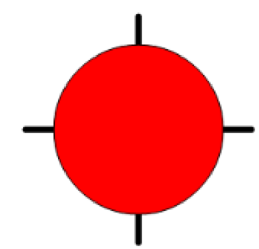


With and without energy storage





With and without dynamic VAr device and storage:
4 quadrant control



Distribution Level Energy Storage

- **Community Energy Storage**
  - Address increasing PV penetration on the distribution system
  - Voltage regulation, frequency regulation, power output fluctuations, voltage flicker, deferment of capacity
  - Locate on circuits with high PV penetration
  - Multi-year deployment
- **Substation Located**
  - Address centralized renewable generation sources
  - Multiple circuits with high PV penetration
  - Voltage and frequency regulation
  - Off-peak energy storage

Initial Projects Integrating Storage

Microgrid Project – Borrego Springs

- Substation level - 500 kW, 1500 kWh Lithium Ion systems
- Community Energy Storage - three 25 kW, 50 kWh systems on circuits
- Residential - Six 4.5 kW, 10.7 kWh at single family dwellings

Smart Grid – Initial AES Deployment

- 500 kW, 1500 kWh Lithium Ion ESS at substation
- Community Energy Storage - three 25 kW, 50 kWh Lithium Ion systems
- Dynamic VAr device – 2 MVA
  - One circuit affected by high penetration of PV

Substation Energy Storage

- One of several planned substation-scale ESS
- Solar Integration using 500 kW, 1500 kWh Lithium Ion
- Demonstrate 4 quadrant control
- Advance modes of operation and evaluate impacts / benefits

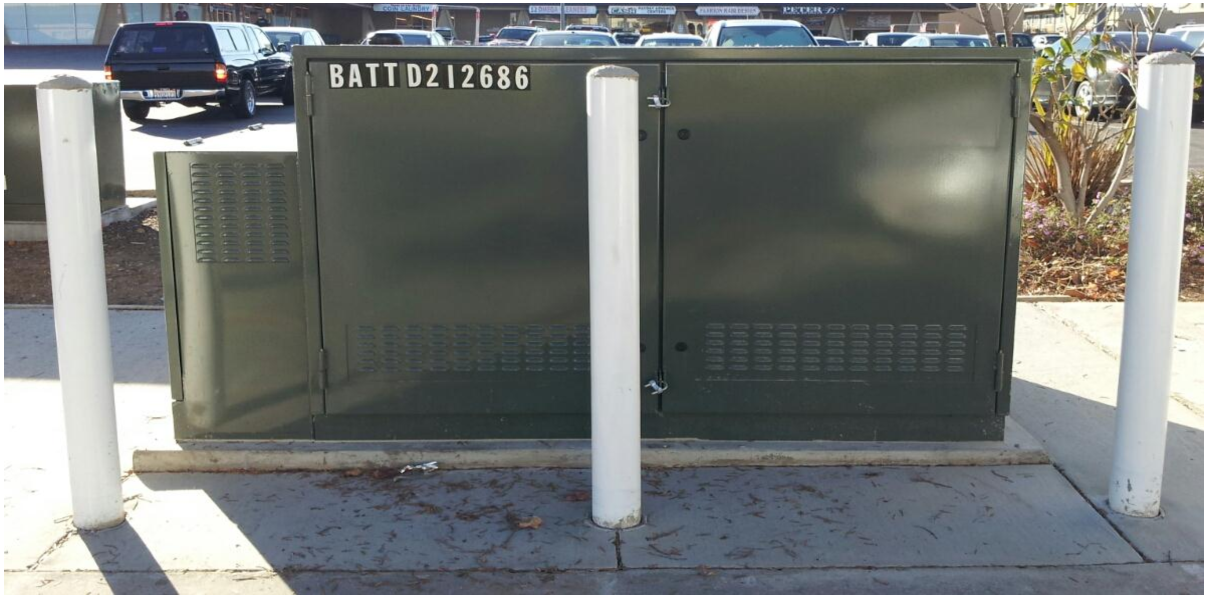
Microgrid – Substation Energy Storage

SDG&E connected
A Sempra Energy utility

- 500 kW, 1500 kWh Lithium Ion ESS
- 4 Quadrant Power Conditioning System (PCS)
- Modes of Operation
  - Peak Shaving/Load Following
  - Renewable Smoothing
  - Support Islanding Operation

Community Energy Storage

- Lithium Ion 25 kW, 50 kWh
- Assess in the field performance at locations suited for ESS siting
- Demonstrate modes of operation and evaluate impacts and benefits



Microgrid – Community Energy Storage

- Three systems connected to distribution circuit
  - 25 kW, 50 kWh Lithium Ion
  - Operated independently and in aggregate
- Modes of Operation
  - Peak Shaving
  - Renewable Smoothing
  - Voltage Support

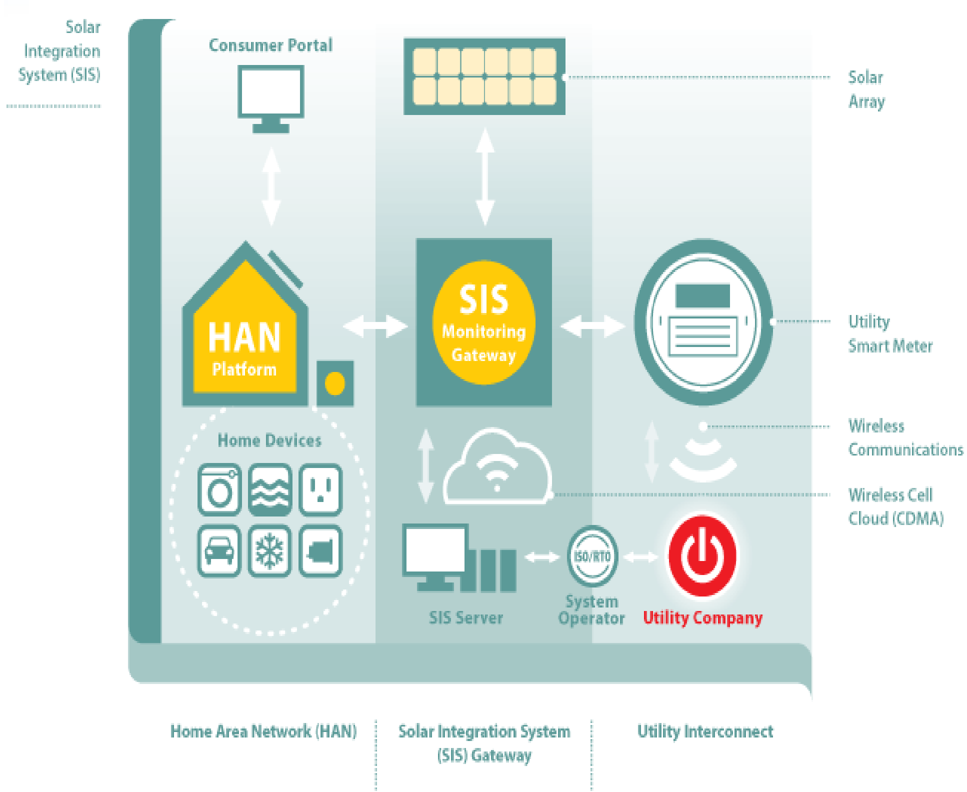
Battery Enclosure

Inverter / 4Q PCS

Below Grade Vault

Microgrid - Residential Energy Storage

- Six 4.5 kW,10.7 kWh Lithium Ion systems, Single Phase, Bi-directional
- Charge/discharge commands sent via Home Area Network (HAN)
- Support Demand Response Operation



AES Deployment History - Challenges

RFP Year	AES Type	Issues/Challenges
2010	SES - Flow Battery	• Vendor unable to meet delivery requirements • No contract granted
2011	SES - Lithium Ion	• PCS Container - A/C systems upgrade • Communication between PCS & battery containers
	CES - Lithium Ion	• Moisture intrusion during Factory Acceptance Test • Battery over discharge due to algorithm bug • Communications challenges between inverter & on-board computer • Siting difficult in the public right-of-way
	HES - Lithium Ion	• Delay due to UL-listing challenges – new category
2012	SES - Lithium Ion	
	CES - Lithium Ion	

AES Deployment - Benefits/Lessons Learned

SDGE connected
A Sempra Energy utility℠

RFP Year	AES Type	Outcome
2010	SES - Flow Battery	• Curtailed deployment plans • Technology development incomplete
2011	SES - Lithium Ion	• Demonstrated multiple modes of operation • Proven 4-quadrant operation • Granular VAr dispatch (alternative to substation capacitors) • Support islanding operation
2012	CES - Lithium Ion	• Scheduled charge/discharge • Peak Shaving at distribution-transformer level • Voltage support at secondary level • Smooth fluctuations caused by rooftop PV systems
2012	HES - Lithium Ion	• Charge/discharge based on schedule • Support Demand Response operation

Thank You!

Victor Romero

Director
Asset Management & Smart Grid Projects